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A Bayesian approach to mixture modelling for detrital geochronology

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Mixture modelling arises in detrital geochronology when we want to determine the number and statistics of age components arising from a range of potential sediment source regions. It is a well known problem in statistics and most methods rely on specifying both the form and number of the component distributions in advance. The need to specify symmetrical distributions can be a problem with geochronological data as some analyses may have suffered loss or gain of the parent or daughter isotopes for a given system, leading to skewness and/or relatively heavy tailed distributions.

Here, we present a recently developed generalised mixture modelling method that avoids these restrictions. We have formulated the problem in a Bayesian framework, with considerable flexibility in the class of distributions we can consider by specifying relatively loose a priori information concerning the form and number of the distributions. In particular, we allow for both symmetical and skewed distributions and estimate parameters associated with these from the data. Furthermore, rather than dealing with the observed ages, as in previous approaches, we make the inferences of components from the unknown 'true' ages, i.e. the ages we would observe had we been able to measure them without analytical error. This avoids allowing the data noise to produce artifacts in the inference. We also estimate the probability distribution on the number of components during the estimation process. This allows a direct, quantitative assessment of the resolution of different numbers of components. We demonstrate our approach with both synthetic and real data.